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& LIME MANUFACTURE

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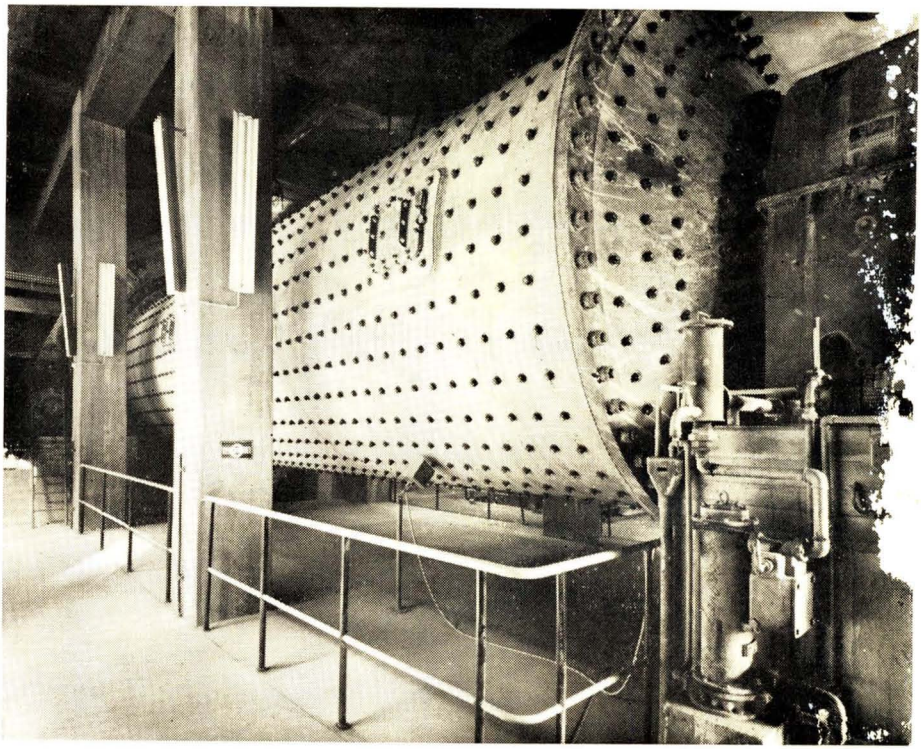

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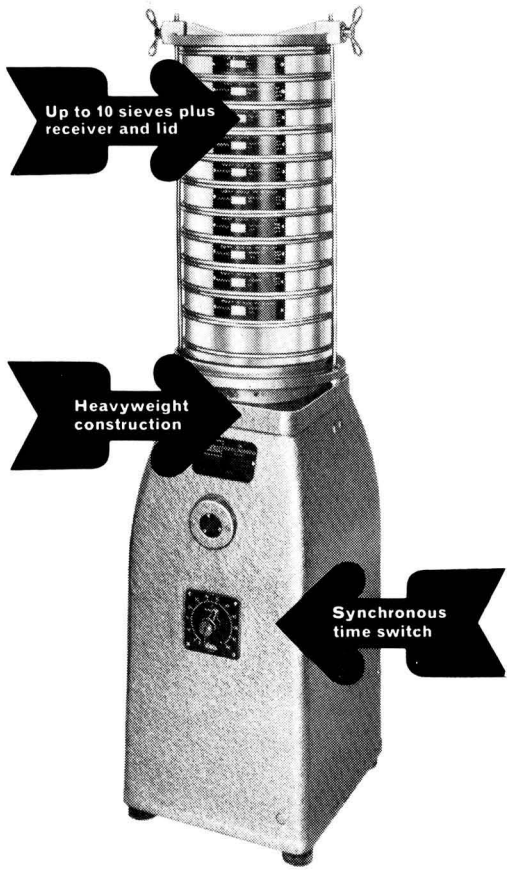

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ENCI Cement Works, Maastricht

ALTHOUGH THE consumption of cement in the Netherlands is some 400 tonnes per capita, there is only one Portland cement works in Holland, since the only deposit of limestone occurs in the extreme south of the country in the vicinity of Maastricht. This works is operated by ENCI (Erste Nederlandse Cement Industrie). Some 2,000,000 tons of Portland blast furnace-slag cement, which represents nearly half the consumption of cement in the Netherlands, is used in that country. A considerable quantity of this cement is made at the Maastricht works but two other ENCI works, one being ROBUR at Roozenburg in the Europoort area and the other EMI (Cement Industrie Jmuiden) at Jmuiden, also produce cement of this type using clinker from the Maastricht works. A visit to the latter was included in the visits open to the participants in the Sixth International Congress of the Precast Concrete Industry (BIBM '69) which was held in Amsterdam in May last.

The ENCI works, a panoramic view of which is shown in the illustration in *Figure* 1, is situated alongside the River Maas at Maastricht and within the raw-materials quarry. The works comprises four principal sections, in the most southerly of which there are three kilns making Portland cement clinker by the wet process. In the northern section there are four older and smaller kilns for the production of Portland-blastfurnace cement and between these two sections is the plant for the treatment and storage of the blast-furnace slag, which is obtained from nearby sources in Belgium. The fourth section contains the recently installed dry-process kiln and ancillary plant for the production of Portland cement clinker.

The Quarry

The working faces of the quarry from which the raw materials are obtained is principally behind the works itself. The deposits comprise an overburden some 10 m. (34 ft.) to 15 m. (50 ft.) thick which is a clayey material suitable for cement

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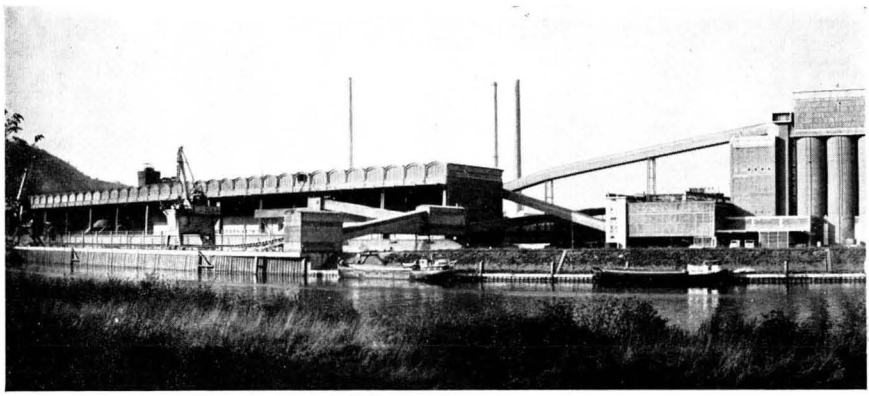


Fig. 1.—ENCI Cement Works, Maastricht (*Continued on page 65*).

making. Below this lies a thick stratum of soft but high-carbonate (95 to 98 per cent) limestone. A feature of the limestone deposit is the presence of narrow bands of flints, which are excavated with the limestone and are used as grinding media in respect to the latter.

The materials are excavated by electrically-driven machines it being rarely necessary to employ blasting. A gravelly material occurring in the overburden is used for forming ramps for access to the working faces. The removal of so much material from one of the few eminences in Holland causes some environmental concern, but care in excavating and the establishment of amenity plans will ensure that in the future the area will again become a scenic attraction. At one time, building masonry was obtained from this quarry, the entries to the galleries being still visible high up on the quarry face.

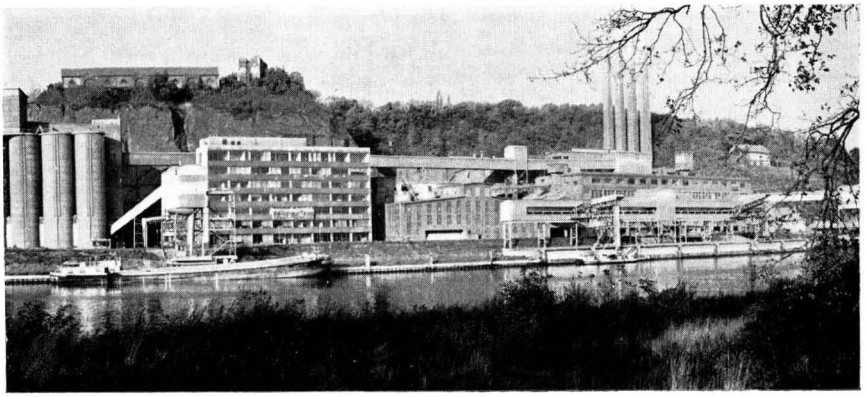
The excavators load the quarried material into "Mack Trucks" each containing some 30 tons. The material is discharged from the lorries into a large and deep crusher pit in the floor of an extensive crusher hall. Conveyors below the bottom of the pit extract up to 1,000 tons of limestone daily.

The only materials required to be brought to the works are iron oxide and gypsum.

The subsequent treatment of the material is included in the following description of the dry-process plant.

THE NEW DRY-PROCESS PLANT

The dry-process was selected for the extension of the plant because of the advantages of low fuel-consumption, improved process-control, a smaller quantity exhaust gas, increased production for a kiln of given dimensions, and lc energy consumption. Such an installation has in this case certain disadvantages such as expensive separation of limestone, flint and pieces of very hard limestone, the provision of an extra air-inlet at the dryer, high dust-load at the precipitator



(*Continued from page 64.*)

inlet, important and expensive installations for the blending and homogenising of the raw material, higher grinding costs compared with the wet-grinding of the raw materials, and about 5 per cent higher investment compared with the wet-process.

The plant, which is shown diagrammatically in *Figure* 2, comprises the following:

Storage of the primary-crushed limestone and flint.
Two feeders for clay and pyrites.
Two secondary crushers.
Stockpile for raw materials before blending.
Raw-material feed and transport to dryer.
Limestone dryer utilising the kiln exhaust-gases.
Electrostatic precipitator.
Transport and screening of dried limestone and separation of flint and very hard limestone.
Storage and feeding of coal-shale (83 per cent ash) to crusher and silo.
Feeding of three raw materials to mill (blending).
Grinding of the blended raw materials in the mill.
Homogenising and storage of ground raw-materials and kiln-feed.
Kiln with cyclones and planetary cooler.
Fuel burner and coal-shale (50 to 60 per cent ash) into the burning-zone.
Grinding of clinker and transportation to store.

The flow-sheet in *Figure* 3 indicates the main data regarding the weights of materials involved, the flow of gases and the temperatures, and correspond to a production 3,000 tons of clinker per day, which is the capacity of the new kiln.

Raw Materials: Pre-blending

The limestone from the primary crusher is fed into a specially-installed storage hopper from which the secondary crushers are fed. The hopper, the capacity

of which is 400 tons, has a constant-volume feeder through which are fed intermittently 500 tons of limestone (0 to 300 mm.; 0 to 12 in.) onto a belt-conveyor. The clay and pyrites are added to the material while on the conveyor, the resulting mixture being 950 kg. (2,095 lb.) of limestone (including flint), 45 kg. (99 lb.) of clay and 5 kg. (11 lb.) of pyrites. This ratio is maintained constant by computer-control.

The mixture of raw materials of size 0 to 300 mm. is transported on inclined belt-conveyors to the secondary crushers. This crushing process is necessary because, at the dryer, the size has to be 50 mm. (2 in.) down and a separation in the stockpile of sizes over 150 mm. (6 in.) is to be expected. Material between 130 mm. ($2\frac{5}{8}$ in.) and 300 mm. (12 in.) are crushed to 50 mm. (2 in.) in a jaw-crusher because pieces of this range of sizes consists of hard and abrasive flint and hard limestone, and low abrasion may be expected in this type of crusher. Material under 130 mm. in size is crushed to 50 mm. or less in a twin-roller crusher, to prevent clotting of the soft and wet limestone, in which the moisture in the raw material is concentrated.

The flow of crushed pre-blended raw materials, now in size 0 to 50 mm. (2 in.) is transported on a belt-conveyor for storage in a circular covered building which

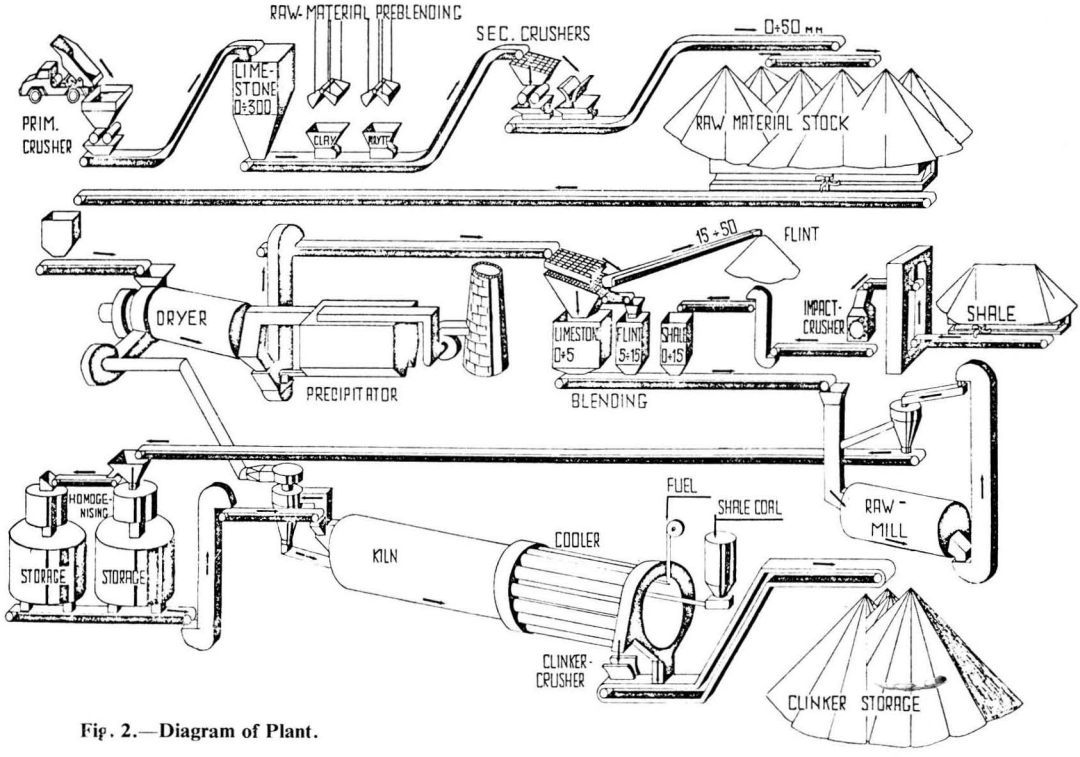


Fig. 2.—Diagram of Plant.

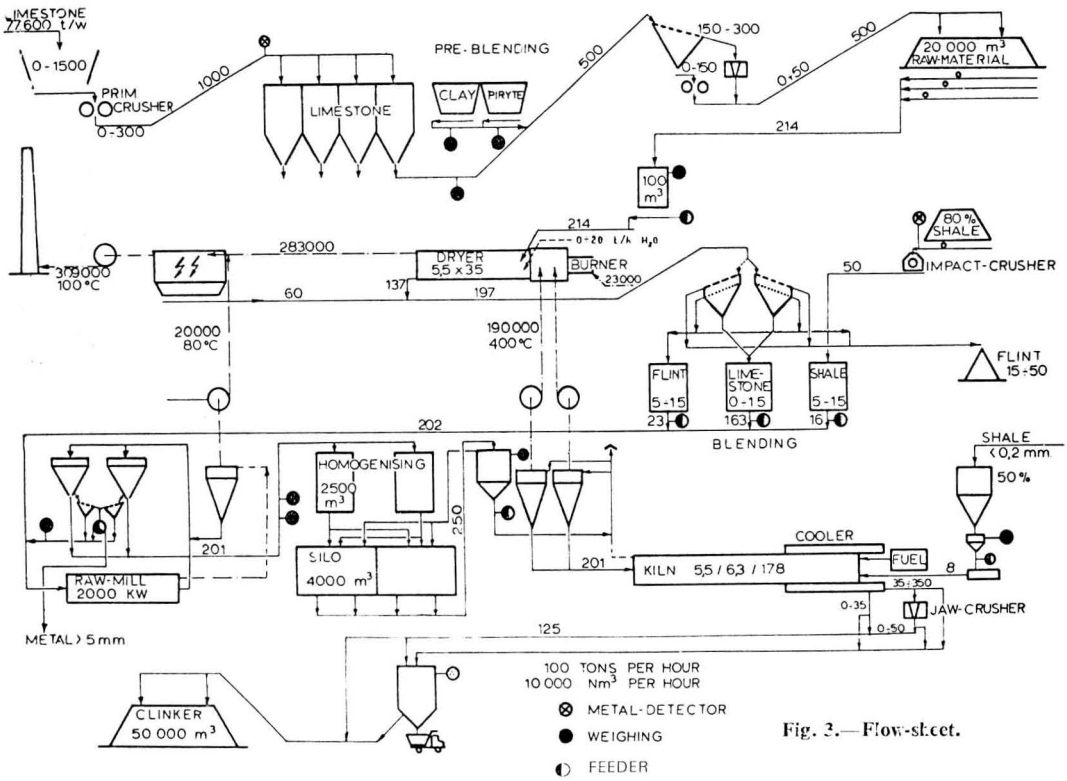


Fig. 3.—Flow-sheet.

has a capacity of 20,000 cu. m. The conveyor from the secondary crusher discharges the raw material onto a reversible shuttle-conveyor, which is moved every 90 minutes over a length of 6 m. (20 ft.). Thus there are fifteen piles of raw materials. The shuttle-conveyor returns to its initial position every twenty-four hours, the production of the quarry in one day having been spread throughout the store. On the following day, fifteen batches of material are spread over those of the previous day; this is repeated until the store is full.

Below the store, there are three plough-feeders which, one by one, move in one hour from one end of the store to the other. Every hour 300 tonnes of the average material obtained from the quarry in one day is extracted from the store. By changing the sequence of the piling of the raw material, it is possible to spread a production of two or three days over the area of the store. The three plough-feeders operate one after the other, so that the stockpile is emptied uniformly. Since the quarry works only five days a week compared with continuous operations of the kiln, the stockpile acts as an accumulator.

Raw Materials Dryer and Ancillary Plant

The plough-feeders below the stockpile feed 300 tons of limestone per hour onto a belt-conveyor, which intermittently discharges into a hopper of 100 cu. m. capacity mounted on load-cells by means of which the feed is controlled. A suitable apron-feeder, which is attached to the limestone hopper, discharges the limestone into the dryer. Assuming that the weight of the limestone does not vary considerably, a periodical verification of the apron-feeder gives sufficient data regarding the tonnage fed into the dryer.

The drum-type dryer, 5·5 m. (18 ft.) in diameter and 35 m. (115 ft.) long and inclined at a slope of 30 per cent, is situated immediately behind the kiln. A drum-type dryer was selected because of the high reliability and the fact that there is practically no wear, that the dust content of the gases is controllable and that the drying capacity is high even with large moisture-contents. Also, the long period during which the material is retained in the dryer offers the possibility to dry pieces of material from 10mm. ($\frac{3}{8}$ in.) to 50 mm. (2 in.). These advantages are considered to offset the fact that the capital cost is twice to three times that of a flash-dryer.

The hot exhaust gas passes through ducts from the kiln into the gas-inlet chamber being activated by fans. In the inlet chamber, the gases can be mixed with additional hot air from an oil-fired air-heater. The heat in the kiln-gases is sufficient to dry raw material having a moisture content of 10 per cent so that, if the moisture content exceeds this amount, additional heat is introduced into the system. The air-heater alone can dry 100 tons per hour of limestone with 10 per cent moisture content. The kiln gases and air heater together can dry 250 tons per hour of limestone having a maximum moisture content of 16 per cent.

The wet limestone is fed into the dryer at the end of the air-inlet chamber. The dryer rotates at 2·5 r.p.m. and is driven by a 300-h.p. constant-speed motor. At the outlet of the dryer, there is an elevator for transporting the dried material. The gas-ducts to the electrostatic precipitator are above the outlet.

No by-pass for the gases is provided at dryer. In the event of an interruption to the feed, the kiln gases are cooled by water injection. The gases from the dryer enter the precipitator at a temperature of 120 deg. C., the dust-concentration at entry being very high, namely, an average of 250 g. per cu. m. and a maximum of 350 g. per cu. m. A mechanical dust-separator is provided in the gas-ducts to the precipitator. The latter comprises two parallel large housings, and has a capture-efficiency of over 99·97 per cent. The gases leaving the precipitator contain less than 100 mg. per cu. m. The dust captured in the precipitators is added to the dried limestone at the end of the dryer.

The gases pass through the dryer and the precipitator by suction from a single-entry constant-speed radial fan which forces the gases into a chimney 150 m. (500 ft.) high. The capacity of the fan is controlled by a radial vane damper.

TABLE I.—BLENDED COMPONENTS

PRE-BLENDING in raw-material stockpile KG/TON CLINKER

	H_2O %	WEIGHT WET	WEIGHT DRY
LIMESTONE	12	1463	1287
FLINT	–	146	146
CLAY	15	77	65
PIRYTE	10	8	7
		1694	1505

91 KG. FLINT ARE SEPARATED BY SCREENING AFTER THE DRYER

BLENDING in raw-material mill KG/TON CLINKER

	H_2O %	WEIGHT WET	WEIGHT DRY	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	K_2O	Na_2O	IGNL	REST
LIMESTONE	12	1463	1287	55,1	6,2	7,1	664,0	12,9	0,1	0,8	538,5	2,3
FLINT 5/15	–	55	55	49,5	–	–	3,1	–	–	–	2,4	–
CLAY	15	77	65	50,0	5,3	2,5	2,0	0,3	1,0	0,6	3,2	0,1
PIRYTE	10	8	7	0,8	–	5,5	–	–	–	–	0,1	0,6
SHALE 83%	6	113	108	47,1	26,1	7,3	2,3	1,6	4,0	0,6	18,2	0,8
		1716	1522	202,5	37,6	22,4	671,4	14,8	5,1	2,0	562,4	3,8

ultimate blending in kiln KG/TON CLINKER

SHALE 50/60	10	85	77	22,0	10,6	3,3	1,0	0,8	1,9	0,3	36,6	0,5
		1801	1599	224,5	48,2	25,7	672,4	15,6	7,0	2,3	599,0	4,3

Screening and Blending Raw Materials

The dried raw materials are transported by an elevator and a belt-conveyor to twin-deck screens mounted above a 1,500-cu. m. silo. The materials are screened to the following fractions:

0 to 5 mm. (0·2 in.): limestone + clay + pyrites; flint 1 per cent.

5 to 15 mm. (0·6 in.): flint + hard limestone; $CaCO_3$ 5 per cent.

15 to 50 mm. (2 in.): flint + hard limestone rejected from the process.

A third component in the blending is coal-shale which has an ash-content of not less than 83 per cent to avoid too much coal being mixed into the raw materials. The coal-shale is graded from 50 mm. (2 in.) to 150 mm. (6 in.) as stocked, but is crushed in a hammer-mill down to 0 to 15 mm. (0·6 in.) and stored in a silo next to that in which flint, graded from 5 to 15 mm (0·2 to 0·6 in.) is stored. The silos for the ground limestone, flint and coal-shale are situated at the inlet of the grinding mill for the raw materials. The blending is carried out by apron-feeders, which discharge predetermined volumes of the three components into the mill. *Table I* shows the relative quantities of the blended components, together with final blend in the kiln.

The flint mixed with the material obtained from the quarry and graded from 5 to 15 mm. is only partially used, the remainder being rejected together with flint exceeding 15 mm. After passing through the dryer, the flint is separated from the limestone + clay + pyrites.

Coal-shale of 50 to 60 per cent ash is introduced together with the flame into the burning-zone of the kiln. The raw-materials mill-building houses a 2,000-k.W. mill and two 6·3 m. (21 ft.) separators, the grinding capacity of this plant being 250 tons per hour. The material is ground down to a fineness such that only 15 per cent exceeds 90 μ. An elevator having a capacity of 300 tons per hour is attached to each separator. The rejects from the separators pass over a vibrating screen having a 4-mm. (0·16 in.) mesh. Metallic pieces greater than 4 mm. are extracted by a magnetic drum, and all non-magnetic particles, such as flint, over 4 mm. in size are returned to the mill. The dust from the mill is dealt with by the electrostatic precipitator attached to the kiln.

Raw Material Blending and Kiln Feed

Transportation of the ground raw materials, the raw meal, to one of the two blending silos is carried out intermittently by means of an elevator and a belt conveyor. Each 100 tons of meal is automatically analysed as it enters the silo the average composition of all the meal in the silo being thereby calculated, ar the feed to the mill being then altered if necessary.

When a silo is full, air is introduced in order to homogenise the meal, a process which takes about two to four hours. Upon completion of blending, the meal is discharged into two storage silos below the blending silos, from which the kiln is fed simultaneously. The meal is discharged through four regulating valves into a pneumatic conveyor leading to an elevator which discharges the meal into a small feed hopper having a capacity of about 10 cu. m. Any overflow from this hopper returns to the meal storage. From the feed hopper, which is mounted on load-cells permitting calibration of the kiln-feed, the meal is discharged by means of a weight-control valve on a belt-conveyor on which the meal is transported to the feed-end of the kiln. The meal is poured into the hot kiln-gases which are thereby reduced in temperature from 500 to 400 deg. C. The hot meal is now separated in the cyclones and fed into the kiln through a refractory-lined steel pipe.

Burning and Cooling

The kiln (*Figure* 4) is 178 m. (584 ft.) long, two sections being 6·3 m. (21 ft.) and 5·5 m. (18 ft.) in diameter. It is set at a slope of 3 per cent. Such a long kiln is unusual with the dry process, but in this case it was necessary as the daily output of clinker is 3,000 tons.

Chains are provided for a distance of 14·5 m. (48 ft.) at the feed-end, and this is followed by a section 36 m. (120 ft.) long with a refractory steel heat-exchange system. The remaining length of the kiln has a refractory lining 250 mm. (10 in.) and 300 mm. (12 in.) thick.

The kiln is driven by two 600-h.p. d.c. motors which permit running up to 1·45 r.p.m. At the firing end, there is a planetary cooler, which is seen on the left-hand side of *Figure* 4 and which comprises eleven cylinders of 2 m. (6 ft. 6 in.) diameter and 20 m. (66 ft.) long. The secondary air is induced by suction through the cooler cylinders. The burner-platform is a cylinder 35 m. (115 ft.) long and 4·5

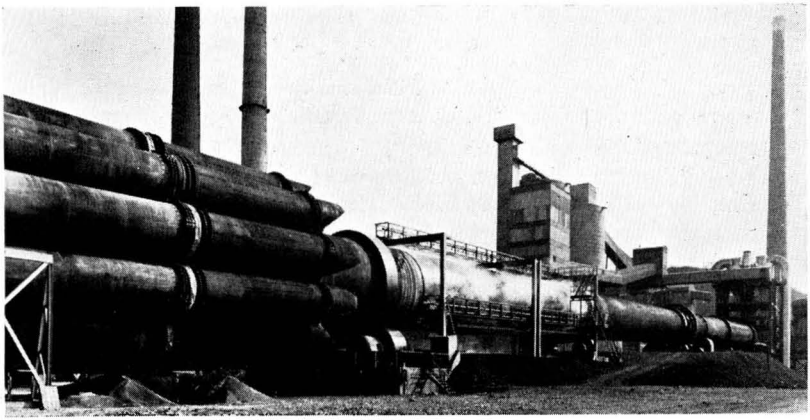


Fig. 4.—The Dry-process Kiln.

m. (15 ft.) in diameter and extends into the planetary cooler to the position where the burner-pipe is installed. Pulverised coal-shale and the fuel-oil are injected into the kiln through the same burner-pipe. Since the size and the arrangement of the burner-platform does not permit the presence of an operator, a TV-camera is installed, the monitor being in the central control-room.

Clinker Storage and Transport

At the outlet of the cooler there are screens with 50 mm. (2 in.) mesh. Material passing the screens drops into a bucket-chain conveyor, while clinker greater than 50 mm. (2 in.) in size is passed to a jaw-crusher and reduced to a size of about 40 mm. (1·6 in.) and are then added to the clinker in the bucket-conveyor. The clinker may then proceed by means of another bucket-conveyor to the clinker store, or by way of a third bucket-conveyor to a hopper from which lorries can be loaded directly. This hopper, which is on load-cells, can be used for weighing periodically the production of clinker.

The clinker store is an enclosed cylindrical tent-like structure having a capacity of 50,000 cu. m., that is sufficient to contain 80,000 tons of clinker. The material is fed into the store from a central tower, the latter also being used for storing clinker of a different quality. The clinker is removed from the store by three belt-conveyors in tunnels below the floor, and is then transported by two other belt-conveyors to the cement mills in the older part of the works or directly to the wharf for loading into ships.

Electrical Installation

The electrical power installed exceeds 7,000 kw, but the normal load is about 4,500 kw. A 10-kv. distribution station is provided below the dried-limestone silo and from this the mill, the kiln-drives and two 500-v. sub-stations are fed. The three fan-drives and the two separator-drives are fed with 3 kv., this system being

adopted because surplus 3-kv. transformer capacity is available. The 220-v. transformer for the lighting is connected to the 500-v. sub-stations.

Control and Automation

The central control room comprises a chemical laboratory, a röntgen spectrometer laboratory, the control-room with control-panel and a Siemens 302-p computer, and conference rooms and other offices.

The sampling of the raw meal is done automatically out of the pneumatic conveyor leading from the separators, a 50-cu. cm. sample being taken from every 5 tons of meal. The average of twenty samples is transported pneumatically to a tablet-press which prepares two samples for the Philips X-ray analyser, which records the content of CaO, SiO_2, Al_2O_3, Fe_2O_3 and K_2O. The K_2O content is necessary because it influences the CaO-reading of the X-ray apparatus. The computer calculates the necessary adjustments to the raw-material feeders to the mill. All machines can be started or stopped from the central control-panel. Detailed information such as current, speed etc, are given on the panels near the plant in the different sections.

The control systems include the following.

The pre-blending of limestone, flint, clay and pyrites is controlled by the computer.

The kiln-control is aimed at keeping constant the incoming variables such as kiln meal-feed, fuel, coal-shale injection, kiln speed and quantity of gas. The computer has no control of the kiln, the task of the computer being to maintain the feed constant. The weighing of the clinker in the silo is, however, commanded by the computer. The clinker transport is also started by a single command from the computer.

The mill-feed is controlled by a special computer-programme which reads the feed, the separator rejects, the intensity of the grinding noise, the separator-vane position and the mill consumption of electric power. The computer also logs several data necessary to make the production-log of the mill.

The computer controls the blending of the raw meal by a regular calibration of the meal-flow to the silos in the weigh-hopper. The average analysis of the meal stored in the blending silo is calculated by the computer and a signal given if the next blending sequence can start. The storage of the meal is regularly checked by the computer by means of a level-indicator and data are given on the available free-storage capacity before a blending silo will be emptied into the storage silo.

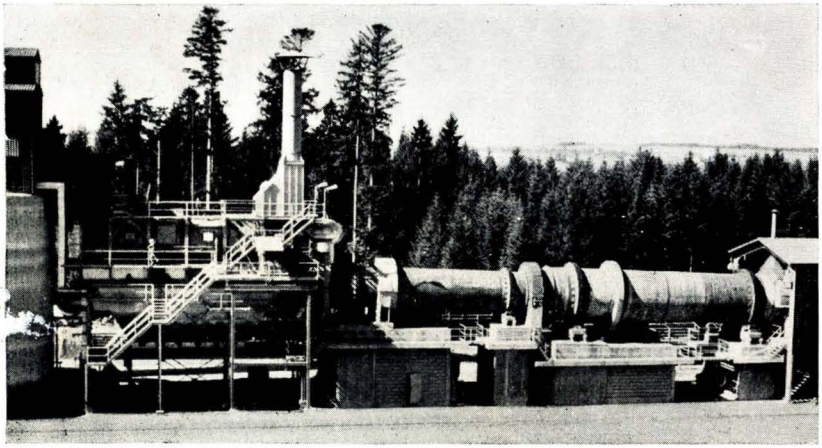
The new plant was started up in the summer and autumn of 1968.

WET-PROCESS PLANT

The wet-process Portland cement plant at the ENCI works receives the raw-meal slurry from the raw-material treatment plant and feeds this into one of three kilns. The first of these kilns is an Allis Chalmers (U.S.A.) plant installed in 1 the second was supplied by Cie de Fives Lille in 195.. Both these kilns kiln-house which also contains ancillary equipment and s. res. These be fired either by pulverised coal or by oil, but generally y are fired

Production of Expanded Clay

with Rotary Kiln and Grate Preheater for throughputs of approx. 50 to 1.000 t/day



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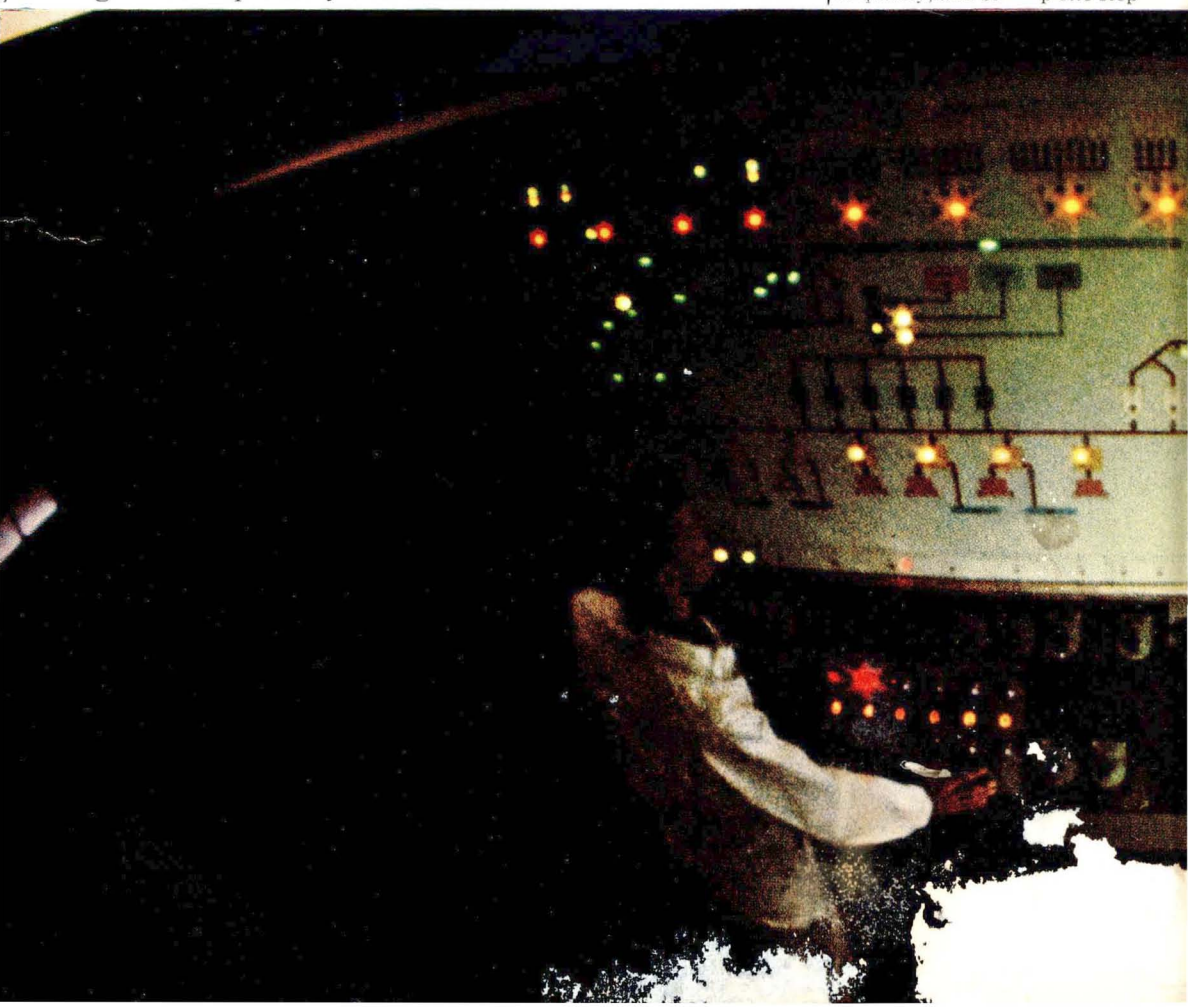

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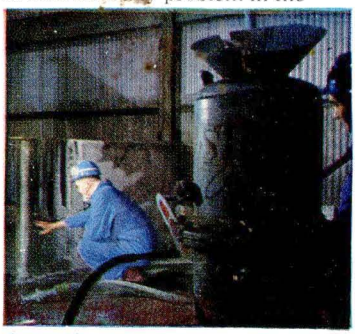

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application of refractory materials. And the Company actively continues to build its expertise and experience. Every employee from the shop floor to senior management receives extensive training. Followed, wherever necessary, by a succession of courses in new and more efficient techniques.

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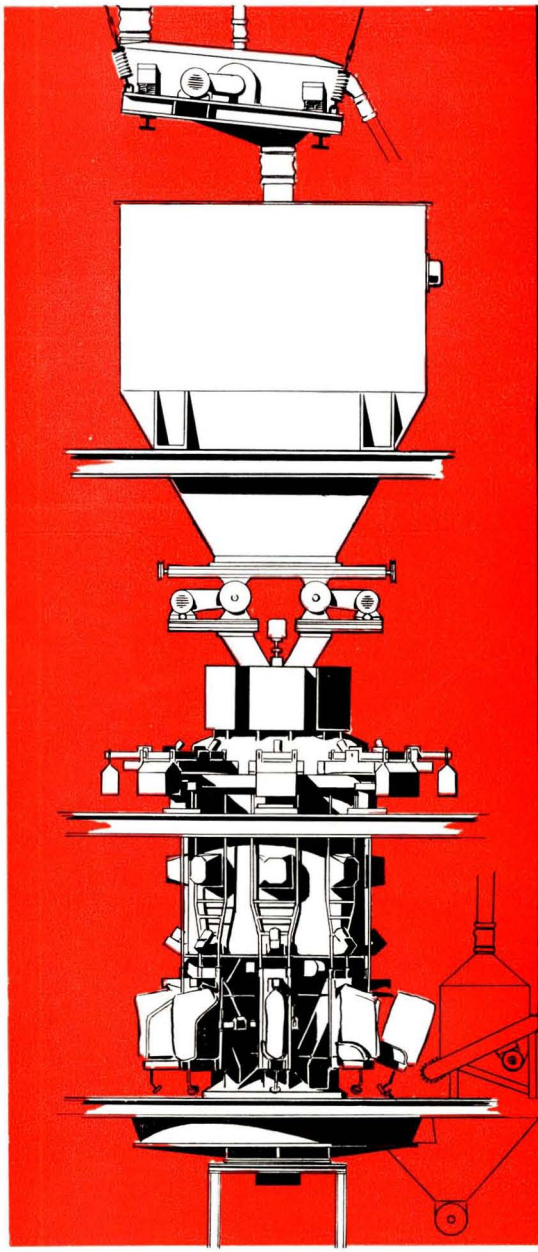

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types of fuel simultaneously through separate injection nozzles, up to 70 per cent. of the fuel being coal. Water sprays are provided for external cooling of the kiln barrel.

The third of the wet-process kilns is coal-fired only and was installed in the early 1960's by Smidt of Denmark. This kiln is in the open as there is sufficient space in the adjacent kiln-house for any ancillary equipment.

The clinker from these kilns is passed to the same grinding mill as the dry-process clinker.

DESPATCH

The Portland cement and the Portland-blastfurnace cement is bagged for despatch by boats which are of 300 tons capacity and can be berthed alongside a riverside wharf at the works. Until recently, a canal ran between the works and the river and this was then used for transport from the works. The canal has now been emptied and only the river is used for the transport of cement and clinker with supplementary facilities by road and rail.

National Standards for Portland Cement

On PAGES 73 to 76 is given the third of a series of tables giving the requirements of most of the national standard specifications for Portland cement. The first table in this series related to the chemical composition and was given in the number of this journal for March last, and the second table, which was published in the May number, related to the tensile, compressive and bending strengths of Portland cement. Some of the data are abstracted from "Cement Standards of the World 1968", but some of the information is in accordance with the requirements of later available Standards. Other revisions may have been effected since these tables were prepared for the press.

In a later number of this journal, it is intended to publish a table giving data relating to the fineness of Portland cements.

The following abbreviations for the various types of Portland cement are used:

O—Ordinary
RH—Rapid hardening (or high early strength)
LH—Low heat
SR—Sulphate resistant
AE—Air entrained

In **Table I,** in the March number, in the U.S.A. requirements for cements Types II and IIA, the silica content is given as " not greater than 21 per cent " whereas this should be "not less than 21 per cent".

Cement Terminology

A DRAFT British Standard has been issued by the British Standards Institution relating to "Definitions and Terminology of Cements". The document includes general definitions, and particular definitions for Portland cements, cements containing blastfurnace slag, high-alumina cements, cements containing pozzolana, additives and masonry cement. Variations from the ISO Recommendations, which it has been necessary to make in order to comply with the requirements of the various existing British Standards for the cements, are indicated.

จุฬาลงกรณ์ กรมวิทยาศาสตร์

TABLE III.—SETTING-TIME AND SOUNDNESS OF PORTLAND CEMENT.

Country	Type of Cement (All types unless otherwise stated)	Setting Times		Soundness Tests				Remarks
		Initial (minimum) minutes	Final (maximum) hours	Hot Pat Test	Cold Pat Test	Expansion (max.) Le Chatelier mm.	Expansion (max.) Autoclave per cent	
Argentina	—	45	10	—	—	—	1·0	—
Australia	—	60	12	X(6)	—	5(6)†	—	†3·0 mm. after 7 days' aeration
Austria	—	60	12	X(2)†	—	—	—	†Repeat after 3 days' aeration if test fails
Belgium	—	45	<3 >12	—	—	6(5)†	—	†If test fails repeat after 24 hours' aeration
Brazil	O RH	60 60	10 10	— —	— —	— —	0·8 0·8	— —
Britain	O & RH LH SR	45 60 45	10 10 10	— — —	— — —	10(1)†	—	†5 mm. after 7 days' aeration if boiling test fails
Bulgaria	—	60	10	X(2-4)	X	—	—	—
Canada	—	45 Vicat 60Gillmore†	8 8	— —	— —	— —	1·0 1·0	†Vicat controls if in dispute
Chile	O HS	60 45	10 10	X(5) X(5)	X X	— —	— —	— —
China	—	45	12	X	—	—	—	—
Cuba	—	45 Vicat 60 Gillmore	10 10	— —	— —	— —	0·5 0·5	— —
Czechoslovakia	O/HS RH	60 30	12 6	X(3)†	X	—	—	†Repeat after 3 days' aeration if test fails
Denmark	O RH	60 45	15 15	— —	X X	10(3)† 10(3)†	— —	†Used if time is short; if failure, cold-pat test controls —

Eire	—	45	10	—	—	5(1½)†	—	†2·5 mm. after 7 days' aera if boiling test fails
Finland	O RH LH	60 45 120	6 6 8	— — —	— — —	— — —	1·0 1·0 1·0	If no autoclave test, use boiling test (or Le Chatelier test) and cold-pat test
France	—	30	—	—	—	3(3)†	—	†3 mm. after storage in water for 7 days. If more than 3% MgO prolong boiling until expansion during 2 hours is constant
Germany (East)	—	60	12	X(2)†	—	5†	—	†If test fails repeat after 3 days' aeration. Kallauna-Rosa to be used if in dispute. Cements with suffix W may not have repeat tests
Germany (West)	—	60	12	X(2)†	—	—	—	†If test fails repeat after 3 days' aeration
Greece	—	60	12	—	X	—	—	—
Hungary	—	60	12	X(3)	X	—	—	—
India	O & RH LH	30 60	10 10	— —	— —	10† 10†	0·8†† 0·8††	†5 mm. after 7 days' aeration if unaerated test fails †† If required
Indonesia	—	60	—	—	—	10(3)	—	—
Israel	O HS SR	45 45	10 10	— —	— —	10(1) 5(1)	0·3† 0·8†	†Also for HS, if agreed †SR only. Obligatory
Italy	—	45	12	—	—	10(3)	—	—
Japan	—	60	10	X(1½)	X	—	—	—
Mexico	—	45 Vicat 60 Gillmore	— 10	— —	— —	— —	0·8 0·8	In case of dispute Vicat controls
Netherlands	—	60	—	X(3)	X	10(3)	—	—
New Zealand	O & RH LH	45 60	10 10	— —	— —	10(1)† —	0·5 —	†5 mm. after 7 days' aeration if unaerated test fails

TABLE III.—SETTING-TIME AND SOUNDNESS OF PORTLAND CEMENT *(Continued)*

Country	Type of Cement (All types unless otherwise stated)	Setting Times		Soundness Tests				Remarks
		Initial (minimum) minutes	Final (maximum) hours	Hot Pat Test	Cold Pat Test	Expansion (max.) Le Chatelier mm.	Expansion (max.) Autoclave per cent	
Norway	O RH	60 45	10 10	— —	— —	5(3)	—	—
Poland	—	60	8	—	—	4(3)†	—	†Repeat after 7 days' aeration if test fails
Roumania	O1 & O2 RH 1 & 2	60 45	10 10	X(2)	—	10(2)	—	—
South Africa	—	45	10	—	—	10(1)†	—	†5 mm. after 7 days' aeration if unaerated test fails
Spain	O1 & SR1 O2 & 3, SR2	45 30	12 10	— —	— —	— —	1·0 1·0	— —
Sweden	O RH LH	60 45 180	6 6 8	— — —	— — —	10(3) 10(3) 10(3)	— — —	— — —
Switzerland	O HS	150† 60	15 15	X(2) X(2)	X X	8(2) 8(2)	— —	†But not substantially less —
Taiwan	—	45 Vicat 60 Gillmore†	— 10	— —	— —	— —	0·5 0·5	†In case of failure Vicat controls
Turkey	—	60	10	—	—	10(4)	—	6 hours boiling when MgO > 3
Uruguay	—	45	10	—	—	—	0·9	—
U.S.A.	—	45 Vicat 60 Gillmore†	— 10	— —	— —	— —	0·8 0·8	†In case of dispute Vicat controls
U.S.S.R.	—	45	12	X	—	—	†	†If MgO in clinker > 5% no limits
Venezuela	—	45	—	—	—	—	0·8	—
Yugoslavia	—	90	10	X(3)	X	10(3)	—	—

Endothermal DTA Peak Preceding Exothermal Devitrification Peak for Vitreous Blast-furnace Slag

By J. E. KRUGER* and M. S. SMIT*

SUMMARY

Attention is drawn to the endothermal peak on the DTA curves for vitreous blast-furnace slags. This peak immediately precedes the exothermal peak due to the devitrification of the vitreous slag. Samples of three vitreous blast-furnace slags were heated to the temperature where the endothermal peak commences, that is 720°C. Some samples were rapidly cooled from 720°C. while others were soaked at this temperature and then cooled at 0·5°C. per min. to room temperature in air as well as in a nitrogen atmosphere.

Data obtained from DTA, TGA, X-ray diffraction and density determinations on the heat-treated samples support the opinion that the endothermal peak is due to an enthalpy change of the glassy slag in its glass transformation temperature range, similar to the glass transformation that occurs in other types of glass.

Introduction

When vitreous blast-furnace slags are heated to temperatures of about 800° to 900°C., devitrification takes place. Devitrification manifests itself on the DTA curves for such slags as an exothermal peak [1, 5].

Immediately preceding the devitrification peak, an endothermal peak appears on the DTA curves for most slags. This peak has been observed by a number of research workers [2, 3, 5].

Schrämli [3] believes that the endothermal peak is due to the absorption of heat by the system and that the heat is required to give the glass the necessary mobility to assume the crystalline structure. Mtschedlov-Petrossian *et al.*[2] attribute the peak to dehydration and decarbonation. Krüger *et al.*[5] report that thermogravimetric analyses of several slags exhibiting the endotherm showed no detectable weight loss in the vicinity of the peak. They believe it is possible that the slag sinters at about 800°C., but that, when melting (accompanied by the initial endothermal reaction) sets in, the mobility of the glass system is suddenly increased to the level where crystallization begins spontaneously and, thus, that the endotherm which accompanies the process of melting is then dominated by the exothermal crystallization reaction.

It is well known that there is a temperature region, known as the transformation range, in which the physical properties of glasses change noticeably and that DTA curves for annealed glasses show an endotherm due to a transformation[6]. The endotherm is termed the 'annealing dip'[7, 8].

Karsch and Schwiete[4] also observed an endotherm in the vicinity of 700°C. on the dynamic difference calorimetry (DDK) curves they obtained for vitreous blast-furnace slags. They attribute the endotherm to such a transformation phenomenon and mention that the course of their curves in the vicinity of 700°C.

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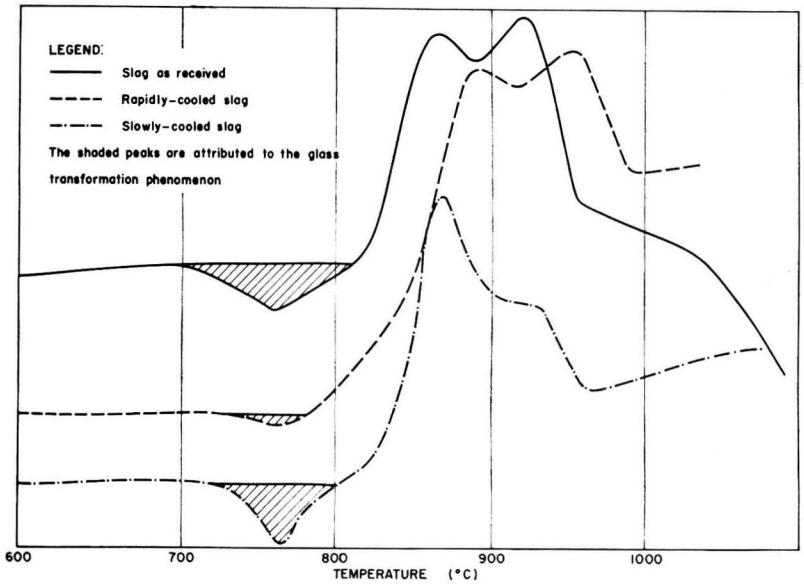

Fig. 1.—DTA Curves for Vitreous Blast-furnace Slag No. 1.

was determined by an enthalpy change in the 'freezing' (annealing) range and point out that DDK curves for all rapidly-cooled glasses show a similar course. It is not clear whether Karsch and Schwiete also investigated slowly-cooled g'asses; as demonstrated below, the slowly-cooled glass should have given a larger peak than the rapidly-cooled glass.

With a view to explaining the endotherm, three vitreous blast-furnace slags were examined.

Experimental

Three vitreous blast-furnace slags, the chemical analyses of which are given in *Table* I, were used in the experiments.

The slags were ground to a fineness corresponding to a specific surface of 3,500 sq. cm. per g. and were then heated to 720°C., that is, to the temperature

TABLE I.—CHEMICAL ANALYSIS OF SLAGS EXAMINED

Constituent	Slag No. 1	Slag No. 2	Slag No. 3
CaO	34·20	28·60	31·00
Al_2O_3	12·80	21·80	17·00
SiO_2	34·60	28·30	30·40
MgO	15·10	18·80	16·00
Fe_2O_3	1·66	0·96	0·50

TABLE II.—DENSITY OF SLAGS HEAT-TREATED IN A NITROGEN ATMOSPHERE

Slag	Heat treatment	Density g. per cu. cm.
No. 1	Heated to 720°C, and rapidly cooled	2·927
No. 1	Heated to 720°C, soaked for 4 hours and cooled at 0·5°C per min.	2·945
No. 2	Heated to 720°C and rapidly cooled	2·971
No. 2	Heated to 720°C, soaked for 4 hours and cooled at 0·5°C per min.	2·998
No. 3	Heated to 720°C, and rapidly cooled	2·958
No. 3	Heated to 720°C, soaked for 4 hours and cooled at 0·5°C per min.	2·981

at which the endotherm commences. Some were rapidly cooled from this temperature to room temperature by quenching in water while others were soaked at 720°C. for four hours and then cooled to room temperature at a rate of 0·5°C. per minute.

The DTA curves for one of the slags untreated, quenched and slowly cooled are presented in *Fig.* 1. The peaks attributed to the glass transformation phenomenon are shaded. In other experiments the slags mentioned in *Table* I were heat-treated as described above, but in a nitrogen atmosphere, to prevent oxidation of sulphides known to be present in the slags. The density of the slags heat-treated in the nitrogen atmosphere was determined. The results are presented in *Table* II; the slags showed no detectable weight change, which indicates that the differences between the densities of the slowly-cooled and rapidly-cooled material are unlikely to be due to weight changes.

Discussion of Results

From *Fig.* 1 it is seen that:

(*a*) DTA curves for the slag heated to 720°C. and then rapidly cooled to room temperature exhibit a small endotherm in the vicinity of 750°C.

(*b*) DTA curves for the slag heated to 720°C. and then slowly cooled to room temperature exhibit an endotherm of considerable size in the vicinity of 750°C. The fact that the slag, when soaked at the temperature at which the endotherm commenced and then cooled, again gave a peak, shows that the changes in the glass that are responsible for the endotherm are reversible.

(*c*) The form of the devitrification peak of the slag heated to 720°C. differs significantly from that of the slag not subjected to heat treatment.

X-ray diffraction and TGA data obtained for the slag showed that:

(i) both the unheated slag and that heated to 720°C. and then cooled to room temperature are amorphous to X-rays.

(ii) the endotherm occurring in the vicinity of 750°C. is unaccompanied by a change in weight.

Results similar to the above were obtained for the other two slags.

Samples of a particular slag slowly cooled from 720°C. had a slightly higher density than samples of the same slag rapidly cooled from 720°C.

The increase in size of the DTA endotherm as the rate of cooling from 720°C. was decreased and the difference in the densities of the slowly-cooled material and the rapidly-cooled material are analogous to the changes observed in DTA curves and densities for other types of glass, changes which are ascribed to a glass transformation phenomenon (Tool and Eichlin[9], Tool [10] and Friedberg[11]).

This work supports the views of Karsch and Schwiete[4] that the endotherm precedes the exotherm owing to devitrification of vitreous blast-furnace slag, that is, that the endotherm is due to an enthalpy change of the glassy slag in its transformation temperature range.

REFERENCES

(1) LOMMATZSCH, A. (1956). Untersuchung von Hochofenschlacke mit der Differentialthermoanalyse. *Silikattechnik,* 7, 468.

(2) MTSCHEDLOV-PETROSSIAN, O. P., LEWTSCHUK, N. A., & SSTRELKOWA, I. S. (1962). Thermische Untersuchung der Schlackenqualität und Beurteilung der Schlackenzugabe in Zementen. *Silikattechnik,* 13, 153–6.

(3) SCHRÄMLI, W. (1963). Zur Charakterisierung von Hochofenschlacken mittels Differentialthermoanalyse. *Zem.-Kalk-Gips,* 16, 140–7.

(4) KARSCH, K. H., & SCHWIETE, H. E. (1964). Untersuchungen über die Kristallisation glasig erstarrter Hochofenschlacken verschiedener Granulationstemperaturen. *Arch. Eisenhüttwes.* 35, 21–6.

(5) KRÜGER, J. E., SEHLKE, K. H. L. & VAN AARDT, J. H. P. (1964). High-temperature studies on blastfurnace slags. *Cem. Lime Mf.,* 37, 3–14.

(6) DAWSON, J. B. & WILBURN, F. W. (1965). The use of differential thermal analysis in the study of the thermal properties of glass. In: *Proceedings of the First International Congress on Thermal Analysis, Aberdeen, Scotland,* 273.

(7) OLDFIELD, L. F. (1965). The use of thermal analysis in glass technology. In: *Proceedings of the First International Congress on Thermal Analysis, Aberdeen, Scotland,* 270–1.

(8) OLDFIELD, L. F., HARWOOD, D. J. & LEWIS, B. (1966). Differential thermal analysis and X-ray diffraction study of devitrification processes. Part I and II, *Journal of Materials Science,* 1, 29–40 and 142–53.

(9) TOOL, A. Q. & EICHLIN, C. G. (1931). Variations caused in heating curves of glass by heat treatment. *Bur, Stand. Res.,* 6, 523–52.

(10) TOOL, A. Q. (1948). Effect of heat-treatment on the density and constitution of high-silica glasses of the borosilicate type. *J. Am. Ceram. Soc.,* 31, (7), 177–86.

(11) FRIEDBERG, A. L. (1963). The structure of glass. *Int. Enamelist,* 13, 21–9.

Associated Portland Cement Manufacturers Ltd.

THE FOLLOWING are abstracts from the Chairman's Statement made at the Annual General Meeting of the Blue Circle Group held in London on July 9 last.

THE DEMAND for cement increased last year by only 1·3 per cent. The industry had asked for a price increase in 1967 of 5s. a ton, but this was limited by the Prices & Incomes Board to 2s. a ton.

The sales of special products had a good year. In particular, "Sandtex" came into its own last year and difficulty was experienced in supplying the demand; therefore an extra production line has been put into operation.

The expansion of operations overseas continued during the year. Deliveries of cement increased by about 7 per cent to 6,600,000 tons. Competitive conditions continued in Australia and Mexico although, in the case of the former, there are signs of an improvement after three years of near-standstill in the increase of cement consumption. Mexico is feeling the aftermath of the large construction boom immediately before the Olympic Games but it is hoped that a resumption of growth in the building industry will become evident in the next twelve months or so. The large new plant in the State of Jalisco is due for completion before the end of the year and there is every expectation of being able to dispose of the whole of this output in the comparatively near future.

The South African Company enjoyed a record year in 1968 largely due to the output of the expanded plant at Lichtenburg, and the building industry in general in South Africa continues to enjoy considerable prosperity.

In the Canadian Company, Ocean Cement & Supplies Ltd., the holding in the Ordinary capital of the Company was increased from about 27 to 52 per cent. A long-term contract was signed during the year with a major U.S.A. consumer for supplies of cement to West Coast markets and it is expected that this additional business will make a useful contribution to the Company's earnings during the next few years.

The war in Nigeria continued to disrupt that country's economy but the expansion of the plant near Lagos is expected to be completed before the end of 1969 to cope with what continues to be a very strong demand. Deliveries in 1968 were a record for the Company.

In New Zealand and Malaysia, the local companies had successful years. Singapore in particular is experiencing a major upsurge in building, and at present the plant there is being doubled in anticipation of a continuation of this trend.

In Spain, the year 1968 was one of consolidation in the cement industry, while the over-production which had become apparent in 1967 was partially absorbed. A greater degree of stability in selling prices became evident during the year. [illegible]tion of the large new plant near Barcelona is well under way and should [illegible] by mid-1970.

[illegible] which A.P.C.M. are shareholders in East Africa participated [illegible]ne revival of the building industry in both Kenya and Tanzania during the [illegible]ears. Arrangements have been finalised for the expansion of the Dar-es-

Salaam plant to more than double its present size during the next two years. T[illegible] plant near Mombasa continues to increase its export business; with this in view, a further bulk-vessel has been ordered, raising the Company's fleet to four ships for supplying a variety of markets around the Indian Ocean.

In the United Kingdom, heavy expenditure is being incurred on new works a Northfleet and Hope and it is hoped that the need for a substantial price increas will be recognised in the near future. Unless some recognition is soon given to the difficulties on the home market, there will be no alternative but to confine future capital investment to overseas companies.

The Rugby Cement Group

THE FOLLOWING are abstracts from the Chairman's speech made at the An[illegible]al General Meeting of the Rugby Cement Group held in May last.

A substantial part of the profits of the Rugby Cement Group now comes from overseas and is a steadily increasing part. While profit margins in the U.K. are held down to an unremunerative level no further major capital investments will be made in this country. It is intended instead to accelerate the expansion of activities overseas. Direct exports of Rugby cement from the U.K. were reduced in 1968 to £222,934, but the expansion of interests overseas led to the export of at least another £1,000,000 in the form of plant. In 1968, overseas' interests accounted for some 26 per cent of the gross sales turnover of just under £26,500,000.

In Western Australia, the subsidiary company Cockburn Cement Ltd. produced increased profits in 1968, its first full year as a public company. A new kiln with a productive capacity of over 300,000 tons per annum came into production last August. In view of the rapidity with which industrial developments in the State are taking place, a substantial programme of expansion has been put in hand. It is in three stages: first, the shipment of bulk cement in a special ship to sites on the coast north of Fremantle; second, the shipment of Portland cement clinker to a grinding plant in the north-west of the state; third, the establishment of a full manufacturing plant in that area as soon as the demand makes this a viable proposition.

In Trinidad, the subsidiary company Trinidad Cement Ltd., also had improved results. A new kiln came into production in December last, and considerable developments are planned. Hitherto, despatches to places outside the island have been shipped from Port-of-Spain, some miles from the plant. Now, as the plant is virtually on the coast, a jetty is being built by the Company so that ships can be loaded direct by conveyor belt.

The Rugby Cement Group acquired, as from the 28 April 1968, the entire sha[illegible] capital of the Rom River Co. Ltd., designers, fabricators and fixing sub-co[illegible] of steel reinforcement. The firm has at present about 12½ per [illegible] of market. Steel reinforcement is so closely allied to cement in co[illegible]struc[illegible] that the extension of the Group's activities into this field can scarcely be called diversification.

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The Manufacture of Portland Cement. DAVIES. New edition in preparation.

Concrete Finishes and Decoration. CHILDE. 1963. pp. 18*s.*; by post 19*s.* ($3.60).

OTHER BOOKS ON CONCRETE AND ALLIED SUBJECTS

Concrete Construction Made Easy. TURNER and LAKEMAN. 1958. 115 pp. 6*s.*; by post 6*s.* 9*d.* ($1.20).

Concrete Construction. REYNOLDS. 1967. 504 pp. 60*s.*; by post 64*s.* 6*d.* ($12.00).

Basic Reinforced Concrete Design. REYNOLDS. 1962. Vol. I. 264 pp. Vol. II. 224 pp. Each volume (sold separately) 24*s.*; by post 25*s.* 3*d.* ($4.80).

Engineering Mathematics (Modern Developments). DOUGLAS with TURNER. 1964. 224 pp. 63*s.*; by post 67*s.* 6*d.* ($12.60).

Theory and Practice of Structural Design Applied to Reinforced Concrete. ERIKSEN. 1953. 402 pp. 25*s.*; by post 26*s.* 6*d.* ($5.00).

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Prestressed Concrete. MAGNEL. 1954. 354 pp. 20*s.*; by post 21*s.* 6*d.* Customers in America should obtain the American edition from McGraw-Hill Book Company, Inc., New York, 36.

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Introduction to Concrete Work. CHILDE. 1961. 120 pp. 4*s.*; by post 4*s.* 9*d.* ($0.80).

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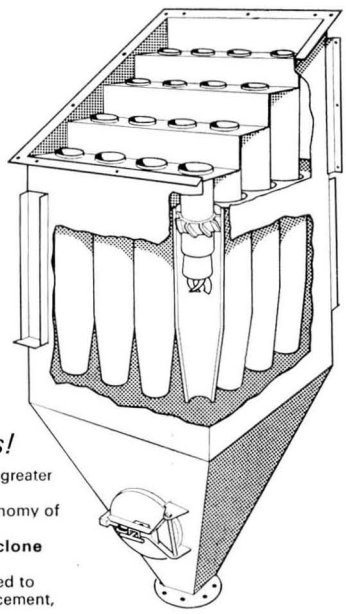

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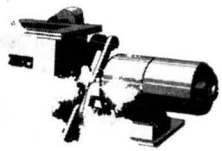

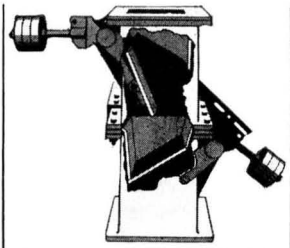

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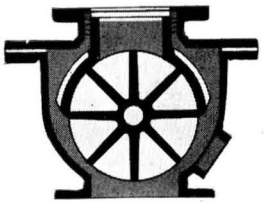

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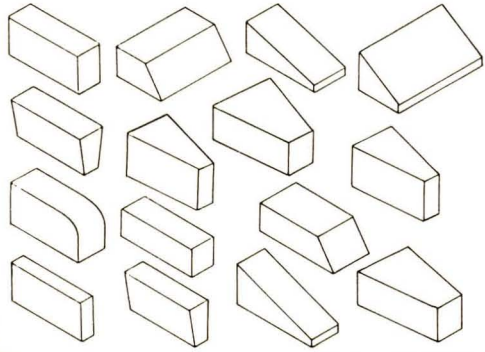

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